

We Claim:

1. A flexible fluid containment vessel for the transportation and/or containment of cargo comprising a fluid or fluidisable material, said vessel comprising:

an elongated flexible tubular structure of woven seamless fabric;

means for rendering said tubular structure impervious;

said tubular structure having a front end and a rear end;

means for sealing said front end and said rear end;

means for filling and emptying said vessel of cargo;

and at least one flexible longitudinal stiffening beam positioned along a length of said tubular structure for dampening undesired oscillation of said tubular structure, said stiffening beam being integral with said tubular structure and subject to pressurization and depressurization.

2. The vessel in accordance with claim 1 which includes a plurality of longitudinal stiffening beams.

3. The vessel in accordance with claim 2 which includes at least two longitudinal stiffening beams positioned equidistant from each other on the tubular structure.

4. The vessel in accordance with claim 3 which includes a third longitudinal stiffening beam positioned intermediate the two longitudinal stiffening beams, with said third beam being so positioned as to provide ballast when filled.

5. The vessel in accordance with claim 2 wherein said stiffening beams are continuous.

6. The vessel in accordance with claim 2 wherein said stiffening beams are made in sections.

7. The vessel in accordance with claim 1 which includes at least one flexible circumferential stiffening beam positioned about a circumference of the tubular structure and integrally formed therewith and being subject to pressurization and depressurization.

8. The vessel in accordance with claim 2 which includes at a plurality of said circumferential stiffening beams.

9. The vessel in accordance with claim 7 wherein said circumferential stiffening beam is continuous.

10. The vessel in accordance with claim 7 wherein said circumferential stiffening beam is in sections.

11. The vessel in accordance with claim 1 wherein the means for sealing an end of the tubular structure comprises collapsing the end upon itself

into a flatten, folded structure, sealing it and securing it mechanically.

12. The vessel in accordance with claim 1 wherein the means for sealing an end of the tubular structure comprises an end cap made of rigid material secured to a perimeter of the tubular structure defining its circumference so as to evenly distribute forces thereon.

13. The vessel in accordance with claim 11 which includes providing a pin seam at an end so as to allow the coupling of a tow bar or another vessel thereto.

14. The vessel in accordance with claim 1 wherein the means for sealing an end includes collapsing, folding, and sealing an end of the tubular structure such that the width of the collapsed and folded end is approximately that of the diameter of the tubular structure.

15. The vessel in accordance with claim 14 which includes a rigid tongue member which is contoured to match the end of the tubular structure and to which the end of the tubular structure is sealed.

16. The vessel in accordance with claim 15 wherein the means for emptying and filling the cargo is located on the tongue member.

17. The vessel in accordance with claim 1 wherein the tubular structure is pod shaped having at least

one end which is collapsed and sealed and includes a vertical flexible stiffening beam at the one end, which is subject to pressurization and depressurization.

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18. The vessel in accordance with claim 1 wherein the tubular structure is woven with fiber reinforcements with the weave used taken from the group consisting essentially of: plain weave (1x1);  
10 basket weaves including 2x2, 3x3, 4x4, 5x5, 6x6, 2x1, 3x1, 4x1, 5x1, 6x1; twill weaves including 2x2, 3x3, 4x4, 5x5, 6x6, 2x1, 3x1, 4x1, 5x1, 6x1; and satin weaves including 2x1, 3x1, 4x1, 5x1 and 6x1.

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19. The vessel in accordance with claim 18 wherein the fiber reinforcements are made of a material taken from the group consisting essentially of: nylon, polyesters, polyaramids, polyolefins and polybenzoxazole.

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20. The vessel in accordance with claim 1 wherein the tubular structure is woven with fiber reinforcements which are made of a material taken from the group consisting essentially of: nylon,  
25 polyesters, polyaramids, polyolefins and polybenzoxazole.

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21. The vessel in accordance with claim 1 wherein said means for rendering said tubular structure impervious includes a coating material on the fabric on one or both sides thereof.

22. The vessel in accordance with claim 21 wherein said coating material is taken from the group consisting essentially of: polyvinyl chloride, polyurethane, synthetic and natural rubbers, polyureas, polyolefins, silicone polymers, acrylic polymers or foam derivatives thereof.

23. The vessel in accordance with claim 19 wherein said means for rendering said tubular structure impervious includes a coating material on the fabric on one or both sides thereof.

24. The vessel in accordance with claim 23 wherein said coating material is taken from the group consisting essentially of: polyvinyl chloride, polyurethane, synthetic and natural rubbers, polyureas, polyolefins, silicone polymers, acrylic polymers or foam derivatives thereof.

25. The vessel in accordance with claim 1 wherein the means for rendering the tubular structure impervious includes weaving the tubular structure with at least two materials, one being a reinforcing fiber, the other being a low melting fiber or low melting component of the reinforcing fiber such that a processing thereof causes the low melting fiber or component to fill the void in the fabric.

26. The vessel in accordance with claim 19 wherein the means for rendering the tubular structure impervious includes weaving the tubular structure with at least two materials, one being a reinforcing fiber, the other being a low melting fiber or low

melting component of the reinforcing fiber such that a processing thereof causes the low melting fiber or component to fill the void in the fabric.

5       27. The vessel in accordance with claim 1 which includes at least two vessels positioned in a side by side relationship, a plurality of beam separators positioned between and coupled to said two vessels, said beam separator being made of flexible material  
10       and subject to pressurization and depressurization.

28. The vessel in accordance with claim 27 wherein said beam separators are made of a woven material.

15       29. A flexible fluid containment vessel for the transportation and/or containment of cargo comprising a fluid or fluidisable material, said vessel comprising:  
          an elongated flexible tubular structure of  
20       woven seamless fabric;  
          means for rendering said tubular structure impervious;  
          said tubular structure having a front end and a rear end;  
25       means for sealing said front end and said rear end;  
          means for filling and emptying said vessel of cargo; and  
          means for reinforcing the tubular structure by  
30       weaving in integrally as part of the fabric thereof reinforcement elements at predetermined intervals along a longitudinal length of the tubular structure.

30. The vessel in accordance with claim 29 wherein said reinforcing means further comprises weaving in integrally as part of the fabric reinforcing elements at predetermined intervals along a circumference of the tubular structure.

31. The vessel in accordance with claim 29 wherein the reinforcing element is taken from the group consisting essentially of: yarns of larger size than yarns that make up the majority of the tubular structure, yarns of higher specific strength than yarns that make up the majority of the tubular structure, rope and braid.

32. The vessel in accordance with claim 30 wherein the reinforcing element is taken from the group consisting essentially of: yarns of larger size than yarns that make up the majority of the tubular structure, yarns of higher specific strength than yarns that make up the majority of the tubular structure, rope and braid.

33. The vessel in accordance with claim 29 wherein the means for sealing an end of the tubular structure comprises collapsing the end upon itself into a flatten, folded structure, sealing it and securing it mechanically.

34. The vessel in accordance with claim 29 wherein the means for sealing an end of the tubular structure comprises an end cap made of rigid material secured to a perimeter of the tubular

structure defining its circumference so as to evenly distribute forces thereon.

35. The vessel in accordance with claim 33 which includes providing a pin seam at an end so as to allow the coupling of a tow bar or another vessel thereto.

36. The vessel in accordance with claim 29 wherein the means for sealing an end includes collapsing, folding, and sealing an end of the tubular structure such that the width of the collapsed and folded end is approximately that of the diameter of the tubular structure.

37. The vessel in accordance with claim 36 which includes a rigid tongue member which is contoured to match the end of the tubular structure and to which the end of the tubular structure is sealed.

38. The vessel in accordance with claim 37 wherein the means for emptying and filling the cargo is located on the tongue member.

39. The vessel in accordance with claim 29 wherein the tubular structure is pod shaped having at least one end which is collapsed and sealed and includes a vertical flexible stiffening beam at the one end, which is subject to pressurization and depressurization.

40. The vessel in accordance with claim 29 wherein the tubular structure is woven with fiber



reinforcements with the weave used taken from the group consisting essentially of: plain weave (1x1); basket weaves including 2x2, 3x3, 4x4, 5x5, 6x6, 2x1, 3x1, 4x1, 5x1, 6x1; twill weaves including 2x2, 3x3, 4x4, 5x5, 6x6, 2x1, 3x1, 4x1, 5x1, 6x1; and satin weaves including 2x1, 3x1, 4x1, 5x1 and 6x1.

41. The vessel in accordance with claim 40 wherein the fiber reinforcements are made of a material taken from the group consisting essentially of: nylon, polyesters, polyaramids, polyolefins and polybenzoxazole.

42. The vessel in accordance with claim 29 wherein the tubular structure is woven with fiber reinforcements which are made of a material taken from the group consisting essentially of: nylon, polyesters, polyaramids, polyolefins and polybenzoxazole.

43. The vessel in accordance with claim 29 wherein said means for rendering said tubular structure impervious includes a coating material on the fabric on one or both sides thereof.

44. The vessel in accordance with claim 42 wherein said coating material is taken from the group consisting essentially of: polyvinyl chloride, polyurethane, synthetic and natural rubbers, polyureas, polyolefins, silicone polymers, acrylic polymers or foam derivatives thereof.

45. The vessel in accordance with claim 41 wherein said means for rendering said tubular structure impervious includes a coating material on the fabric on one or both sides thereof.

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46. The vessel in accordance with claim 44 wherein said coating material is taken from the group consisting essentially of: polyvinyl chloride, polyurethane, synthetic and natural rubbers, polyureas, polyolefins, silicone polymers, acrylic polymers or foam derivatives thereof.

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47. The vessel in accordance with claim 29 wherein the means for rendering the tubular structure impervious includes weaving the tubular structure with at least two materials, one being a reinforcing fiber, the other being a low melting fiber or low melting component of the reinforcing fiber such that a processing thereof causes the low melting fiber or component to fill the void in the fabric.

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48. The vessel in accordance with claim 46 wherein the means for rendering the tubular structure impervious includes weaving the tubular structure with at least two materials, one being a reinforcing fiber, the other being a low melting fiber or low melting component of the reinforcing fiber such that a processing thereof causes the low melting fiber or component to fill the void in the fabric.

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49. A method of coating an elongated flexible tubular structure of woven seamless fabric which has an inside and an outside with said tubular structure

having a length greater than two hundred feet,  
comprising the steps of:

weaving a fabric to create the elongated  
flexible tubular structure having open ends;

5 inserting a liner on the inside of the tubular  
structure which prevents the inside of the tubular  
structure from adhering together;

sealing the open ends of the tubular structure;

coating the outside of the tubular structure;

10 curing the coating to the extent that the  
tubular structure can be inflated;

removing the liner from the tubular structure;  
and

inflating the tubular structure.

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50. A method in accordance with claim 49 which  
includes the step of coating the inside of the  
tubular structure after the outside is coated.

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51. A method of coating an elongated flexible  
tubular structure of woven seamless fabric which has  
an inside and an outside with said tubular structure  
having a length greater than two hundred feet,  
comprising the steps of:

25 weaving a fabric to create the elongated  
tubular structure having open ends;

coating the outer surface with a material that  
has a peeling mode of failure;

sealing the open ends of the tubular structure;

30 and

inflating the tubular structure so as to  
separate any portions of the inside of the tubular  
structure that adhered together as a result of the

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coating passing through from the outside to the inside.

52. A method in accordance with claim 51 which includes the step of coating the inside of the tubular structure after the outside is coated.

53. A method of coating an elongated flexible tubular structure of woven seamless fabric which has an inside and an outside with said tubular structure having a length greater than two hundred feet, comprising the steps of:

weaving a fabric to create the elongated flexible tubular structure having open ends;  
providing means for preventing the inside of the tubular structure from being in contact with itself during coating; and  
coating either the inside or the outside of the tubular structure.

54. A method in accordance with claim 53 which includes the step of coating both the inside and the outside of the tubular structure.

55. A method in accordance with claim 53 which includes the step of weaving the fabric in such a manner that it has a low permeability to air; sealing the open ends and inflating the tubular structure to prevent the inside from being in contact with itself during coating.

56. A method in accordance with claim 53 wherein the means for preventing comprises scaffolding,

inflated arches or inflated bladder or bladders positioned inside the tubular structure.

57. A method in accordance with claim 53 wherein the means for preventing comprises flexible stiffening beams which are woven integral with the tubular structure which are pressurized.

58. A method of fabricating an impervious elongated flexible tubular structure of woven seamless fabric which has an inside and an outside with said tubular structure having a length greater than two hundred feet, comprising the steps of:

weaving a fabric to create the elongated flexible tubular structure having open ends; weaving as part of its fabric, a low melt fiber or component thereof;

providing a device that applies heat and pressure to the fabric to cause the low melt fiber or component thereof to melt and create a structure in which the voids in the fabric are filled; and

preventing the inside from adhering to itself until the structure so formed has set.

59. A method in accordance with claim 58 wherein the device that applies heat and pressure comprises:

a first section having a heating member and magnet member and a means for moving said first section;

a second section having a heating member and magnet member and means for moving said second member; and

wherein said first section is positioned on the inside of the tubular structure, said second section being positioned on the outside of the tubular structure and opposite said first section such that the fabric passes therebetween which is subject to heat from the heating members and pressure caused by the magnets pulling the section together whilst keeping the sections in position.

60. A method in accordance with claim 59 wherein the device includes means for preventing the fabric from sticking to the sections which comprises a non-stick surface contemporaneous with the heating elements.

61. A method in accordance with claim 60 wherein the non-stick surface comprises a non-stick belt that moves contemporaneously with the sections.

62. A flexible fluid containment vessel for the transportation and/or containment of cargo comprising a fluid or fluidisable material, said vessel comprising:

an elongated flexible tubular structure of woven seamless fabric;

means for rendering said tubular structure impervious;

said tubular structure having a front end and a rear end;

means for sealing said front end and said rear end;

means for filling and emptying said vessel of cargo; and

wherein the means for sealing the front end includes collapsing, folding, and sealing the front end of the tubular structure in such a manner so as to create a bow like structure at the front end which is perpendicular to the surface of the water in which the vessel floats.

63. The vessel in accordance with claim 62 wherein said means for sealing said front end further includes securing said front end mechanically.

64. The vessel in accordance with claim 62 wherein said means for sealing said rear end includes collapsing, folding, and sealing the rear end of the tubular structure.

65. The vessel in accordance with claim 64 wherein said means for sealing said rear end further includes securing said rear end mechanically.

66. The vessel in accordance with claim 64 wherein the rear end is in a plane and the front end is in a plane which is orthogonal to the rear plane.

67. A flexible fluid containment vessel for the transportation and/or containment of cargo comprising a fluid or fluidisable material, said vessel comprising:

at least two elongated flexible tubular structures of woven seamless fabric;

means for rendering said tubular structures impervious;

an elongated flexible tubular structure of woven seamless fabric;



means for rendering said tubular structure  
impervious;

said tubular structure having a front end and a  
rear end;

5 means for sealing said front end and said rear  
end;

means for filling and emptying said vessel of  
cargo;

and at least one flexible longitudinal  
10 stiffening beam positioned along a length of said  
tubular structure for dampening undesired  
oscillation of said tubular structure, said  
stiffening beam being maintained within a sleeve  
woven seamless with said tubular structure along a  
15 length thereof and subject to pressurization and  
depressurization.

72. The vessel in accordance with claim 71 which  
includes a plurality of longitudinal stiffening  
20 beams and a plurality of sleeves.

73. The vessel in accordance with claim 72 which  
includes at least two longitudinal stiffening beams  
positioned equidistant from each other on the  
25 tubular structure which are maintained in respective  
sleeves.

74. The vessel in accordance with claim 72 wherein  
said stiffening beams are continuous and said  
30 sleeves are continuous.

75. The method in accordance with claim 53 which includes the step of providing a germicide or fungicide on the inside of the tubular structure.

5 76. The method in accordance with claim 53 which includes the step of providing a UV protecting ingredient on the outside of the tubular structure.

10 77. A flexible fluid containment vessel for the transportation and/or containment of cargo comprising a fluid or fluidisable material, said vessel comprising:

an elongated flexible tubular structure of woven fabric;

15 means for rendering said tubular structure impervious;

said tubular structure having a front end and a rear end;

20 means for sealing said front end and said rear end;

means for filling and emptying said vessel of cargo;

25 and a plurality of longitudinal pockets integrally formed with said fabric containing respective longitudinal reinforcing elements positioned along a length of said tubular structure for reinforcing said fabric and receiving a longitudinal force thereon.

30 78. The vessel in accordance with claim 77 wherein said fabric is continuous and seamless.

79. The vessel in accordance with claim 77 wherein said fabric is made in sections and joined together.

80. The vessel in accordance with claim 77 wherein  
said fabric includes a plurality of circumferential  
pockets having respective circumferential  
reinforcing elements therein positioned about a  
circumference of the tubular structure and  
integrally formed therewith.

81. The vessel in accordance with claim 78 wherein  
said fabric includes a plurality of circumferential  
pockets having respective circumferential  
reinforcing elements therein positioned about a  
circumference of the tubular structure and  
integrally formed therewith.

82. The vessel in accordance with claim 79 wherein  
said fabric includes a plurality of circumferential  
pockets having respective circumferential  
reinforcing elements therein positioned about a  
circumference of the tubular structure and  
integrally formed therewith.